

Bringing Defense into the Information Economy

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Executive Summary

The U.S. defense sector is not experiencing economic gains from the use of IT like those of other IT-rich sectors. In the economy at large, remarkable improvements in IT price-performance over the last quarter-century have yielded greater productivity and better IT-based products and services at lower costs. In contrast, increased defense capabilities, despite their growing IT content, have meant increased costs.

For example, although combat aircraft are now packed with IT, their price-performance is improving little if at all, and the cost of IT-rich naval ships is rising steeply. In contrast, the performance of non-military systems that exploit IT is improving faster than their price, which is often flat or declining. Until defense joins the larger IT economy, either the costs of national security will continue to grow or requirements will go unmet if, as seems likely, defense spending levels off. Indeed, the failure of defense to exploit IT economies is preventing the United States from aligning its core technological strength with its grand strategy, as it did during World War II and the Cold War.

To understand why defense is not following the pattern of the IT economy, four hypotheses are examined:

1. *It just takes time.* Economic gains in defense will inevitably come when organizational cultural and process changes occur that better exploit IT. The counsel here is: be patient.
2. *Defense is different.* The military demands unique complex systems for extreme operating environments, limiting its emulation of the general economy. The counsel is: rely on defense contractors to apply IT in defense, whatever the cost.
3. *It's the bureaucracy.* Acquisition laws, regulations, practices and staffs have overly bureaucratized the acquisition process. Here the counsel is: reduce red tape and things will cost less.
4. *The structure of the defense industry thwarts economic gains from IT.* The defense industry is concentrated in a few prime contractors which are not IT producers, are insulated from commercial IT markets, and either block or absorb potential economies. The counsel here is: end the insulation of the defense industry from the dynamic U.S. economy.

The first hypothesis is wrong and encourages harmful complacency. There has been enough time since major defense IT investment began to see better economic results. Besides, organizational transformation is not needed to see improved price-performance in military systems that incorporate increasing amounts of IT.

The second hypothesis is wrong and encourages harmful management behavior. Defense is not the only sector with unique requirements, and its demands are not so different to explain the divergence in price performance. As long as the defense establishment is daunted by the challenge of applying and integrating IT into military capabilities, it will outsource intellectual leadership and management responsibility to the defense industry.

The third and fourth hypotheses cannot be rejected and are strategically interlinked:

- The acquisition system not only prevents effective and economical application of IT but also buttresses the position of defense lead systems integrators (LSIs) as rent-charging “principal agents” of military customers.
- The services provided by these principal agents include management support that enables the LSIs to shape demand and to increase customer reliance on them, further eroding military competence in exploiting IT.
- The market strength of the LSIs—only they can prime major contracts—is reinforced by the advent of joint networks-of-systems, which cross organizational boundaries and thus make acquisition management even harder for the military.
- The combination of a baroque acquisition system and these strong principal agents deters other companies, including IT leaders, from targeting the defense market, further isolating defense from IT innovations and economies.

In sum, acquisition reform, hard enough as it is, will not produce major economic gains in the absence of defense-industrial restructuring. Using Michael Porter’s 5-factor framework to understand the defense-industrial structure and degree of competition:

- The LSIs have power over both dependent customers and deterred competitors.
- While there is rivalry among the LSIs, it is managed by the defense establishment and by teaming arrangements so that none will be without work.
- Military buyers are disadvantaged by their reliance on LSIs and isolation from the IT economy. Some are trying to bypass the acquisition system to get IT solutions.
- There is little competitive pressure on the LSIs from small defense firms or new entrants, including IT leaders. LSIs control prime contracts and market access.
- Opportunities for new products, especially IT-based solutions, are limited by the weakness of customers and the preference of the LSI’s for traditional systems.

As a consequence of this structure, and an acquisition system that abets it, defense is getting less *value* from IT than other sectors and than it could. As general IT costs decline and the IT content of military capabilities grows, there should be downward pressure on total defense costs. Instead, defense is paying LSIs more for management services associated with the use of IT in military systems, which may account for the lost economies from IT in defense. In turn, these costly management services reinforce the LSIs’ position as principal agents, limiting competition and harming defense economics.

While this is not meant to be more than an exploratory essay—the beginning of a conversation about change—it does point to possible general remedies, namely:

- Ending principal agency by unlocking the hold of LSIs on prime contracts, or unpacking such contracts by increasing customer competence in management. Government should stop promoting customer-contractor “strategic partnerships,” which strengthen principal agency at the expense of affordable defense.
- Building military customers’ understanding of how to exploit and manage IT.
- Favoring defense contractors that participate in and are thus exposed to the economic forces and technological ideas of larger IT markets.
- Lowering entry barriers and deterrence to attract leading IT firms and others into the defense market.

- Removing obstructions to the substitution of IT-based solutions for traditional hardware in meeting operational demands.

The restructuring of defense industry implied by such remedies will, of course, require reform of the acquisition system, which provides de facto government protection for large defense contractors. Yet, practical reform of defense acquisition has proven to be extremely difficult. Still, there is hope: The combination of declining U.S. defense investment (owing to federal fiscal constraints and current military operating expenses) and growing interest in IT solutions on the part of military users should place the existing structure under intensified pressure. A combination of reform and restructuring could put the defense sector on a path to joining the national IT economy and, once again, aligning U.S. core strengths to its grand strategy.

Introduction

Defense and the New Economy—Outside Looking In

The U.S. defense establishment lives in a parallel universe from the American economy. In the larger economy, tumbling costs of information technology (IT) and high returns on IT investments are yielding important gains. Business, generally speaking, is producing more and performing better with less. In contrast, the costs of defense capabilities are going up, sharply. This is not because defense is failing to use IT; on the contrary, the IT content of the weapons, platforms and sensors that make up U.S. defense capabilities is steadily expanding. Yet, despite this, the downward cost trends prevalent in the economy at large are not evident in defense. This anomaly has to be understood and fixed if national security is to be affordable and if national strategy is to be aligned with national strengths.

The United States historically has harnessed both its economic might and its technological genius to its grand strategy. Its World War II strategy was based on vast industrial production. The United States won the Cold War by exploiting its edge in aerospace and nuclear technology and its ability to out-innovate the Soviets. Now, in the Information Age, the world's most inventive and productive IT economy should be the engine-room of national strategy. But it is not.

Granted, the United States is well ahead of the rest of the world in adding military strength by building information networks and incorporating IT into weapons and platforms. But it is doing so at a great and rising cost, both in absolute terms and relative to other public needs. Even as costs of IT and of IT-based products and services fall steeply and steadily in the general economy, the cost of increasingly IT-based military capabilities is increasing. Defense is enjoying the technical fruits but not the economic fruits of the information revolution.

Over the last ten or so years, civilian sectors have reaped huge benefits from investment in IT. For the economy as a whole, this is reflected in rising labor productivity, from under 2% before 1990 to more than 4% from 2000 to 2004.¹ Generally speaking, increases in labor productivity result from applied technological advances; in the case of today's U.S. economy, these advances are coming mainly from computers, communications, and other IT. Concrete examples show the impact vividly. EKGs that were once done only in a hospital are now done in the doctor's office. Highway tolls once had to be collected manually; now EZ-Pass records and bills them. Getting ones bank balance used to require talking to a teller; now it is on the Web. What is more, the costs of these improved systems and services have declined as they have been brought into use. Deep discounts for airline tickets are now at every Internet user's fingertips. Cheaper products, better service, more choice, and lower costs are the norm in business uses of IT.

The norm in defense, on the other hand, is to pay more to get better. Let's be clear: defense *is* benefiting from IT. Precision strike, sensors, and connectivity among forces are all much better thanks to advances in data processing and networking. As the performance of individual systems is enhanced and systems are networked together, overall force capabilities have improved greatly. However—and this is the key point—while the larger economy is enjoying eye-popping gains in

¹ Federal Reserve Bank of San Francisco, "Economy Research and Data," *Economic Letter*, February 18, 2005.

price-performance from IT, defense is experience eye-popping gains in performance at eye-watering prices.

DOD is bucking the information economy's trend and following its own historical price-performance trend, whereby each new generation of combat aircraft and naval vessel outperforms its predecessor but also costs much more. True, as performance increases, DOD can make do with fewer planes and ships. But as costs increase, DOD *must* make do with fewer weapons and platforms. The persistent shrinking of the U.S. naval fleet is not the product of any analysis showing that a little fleet of highly capable ships is preferred but rather the result of staggering growth in the cost of building individual ships, which has continued during the IT age.

One thing is clear: the phenomenon of increasing capability at declining cost now common in retail, financial services, telecommunications and other sectors remains uncommon in defense. Examples of improved performance for less cost, such as unattended aerial vehicles (UAVs) are revolutionary exceptions that prove the conventional rule. Overall, better military capabilities demand more spending. If defense spending flattens but defense needs do not, as is likely, a deficit of capabilities relative to needs will grow. Starkly put, national security will suffer if defense cannot get more capability for less money.

There is a way out of this bind—a “new defense economics.” With large and growing use of IT in defense capabilities, the remarkable gains in IT price-performance discussed below could transform the economics of defense. We say “could” because there is nothing inevitable about it. If we are right, it may be possible to meet growing defense needs with level spending, or to reduce the cost of defense if needs level off. More than possible, it is essential. Defense economics cannot be transformed by trimming some fat here, eking out some efficiency there, or closing some bases here and there, worthy as such measures are. What DOD must do, basically, is to follow the lead of the national economy, which is enjoying sustainable, structural, economic improvement thanks in considerable part to IT.² By doing so, the technological power of the United States can be harnessed to its security, as it was when earlier strategic challenges were met.

Only by learning why defense has not entered the new information economy can steps be taken to correct this glaring anomaly. Four hypotheses to explain it are examined in this essay:

1. It just takes time
2. Defense is different
3. It's the bureaucracy
4. The structure of the defense industry is thwarting economies from IT

Too often these explanations are implicit, as if they were self-evident. In this paper, we will spell out and critique these arguments.

This is an exploratory essay—a pilot analysis aimed at injecting new perspective and questions into the study of the fundamentals of defense economics. It is not the last word. Rather, it is meant to start what management theorist Peter Senge calls a “productive conversation” about the affordability of defense and the alignment of technology, economics, and grand strategy.

² Global economic integration is also contributing to this sustained inflation-free growth, through a shift of labor-intensive production and service provision to low-labor-cost countries with large labor pools (e.g., India and China). Of course, this shift is itself largely the result of the advent and spread of IT.

The Economics of Defense in the Information Age

The demands of U.S. defense are growing and show no signs of slacking. The war with al Qaeda rages on. The need to defend the homeland has been added to the requirement for expeditionary forces. The nuclear ambitions of North Korea and Iran endanger security in Northeast Asia and the Persian Gulf, respectively. China is deploying submarines and missiles that can threaten U.S. military power in the Western Pacific. Force transformation to exploit IT requires more investment than it has gotten so far. National missile defense is in its infancy. The Army and Marine Corps are taxed by a vicious insurgency in Iraq. Good soldiers and sailors are getting harder to recruit and retain. Just as the “big-ticket” requirements of current strategy and future dangers are growing, so are the everyday demands of personnel, maintenance, and operations, including, lest we forget, oil.

Even with such demands, no military establishment can ignore the calculus of costs and performance. It may do so in the short run by throwing more money at problems, or by postponing investment in the military-after-next. But economics have a way of catching up.

Thanks to American politics in the aftermath of 9/11, the Pentagon has been able to meet immediate needs and also to revolutionize warfare by spending more—lots more. Defense budgets have increased by 5% annually in constant dollars since the late 1990s: \$308B in 1998, \$329B in 2000, \$370B in 2002, \$403B in 2004, with \$424B proposed for 2006³. This does not count supplemental funding for the conflicts in Iraq and Afghanistan since 2003, which adds another \$75B or so per year, some of which is investment. If this spending is included, the rate of increase in real costs is more like 6% annually. Given fiscal conditions and other federal needs, and barring some shift in strategic conditions, such as confrontation with China, this growth in defense spending is unsustainable.⁴ The Congressional Budget Office (CBO) projects essentially flat defense spending starting in 2010.⁵ Relative to requirements already identified by DOD, future annual defense shortfalls could be as high as \$80B in current dollars.⁶

With the IT content of military capabilities growing rapidly and the cost of IT dropping rapidly, relief is possible. The information revolution has yielded remarkable increases in the performance of IT and IT-based systems per dollar spent. As shown in figure 1, the costs of increased processing speed, memory, and storage have plummeted for over two decades.⁷

³ These figures are in constant 2004 dollars. See Richard Kugler and Hans Binnendijk, “Shaping Future Defense Budgets,” *Defense & Technology Paper 6* (Washington, DC: Center for Technology and National Security Policy, November 2004).

⁴ It is assumed that further increases in spending to defeat terrorism will be directed more toward intelligence, law enforcement, political action, and other capabilities more relevant than military forces to the evolving, violent Islamist threat.

⁵ More precisely, one-third of one percent per year, per “Shaping Future Defense Budgets.”

⁶ Based on what the services say they need to meet requirements.

⁷ As one would expect from Moore’s Law, which holds that the number of circuits per chip will double every 18 months.

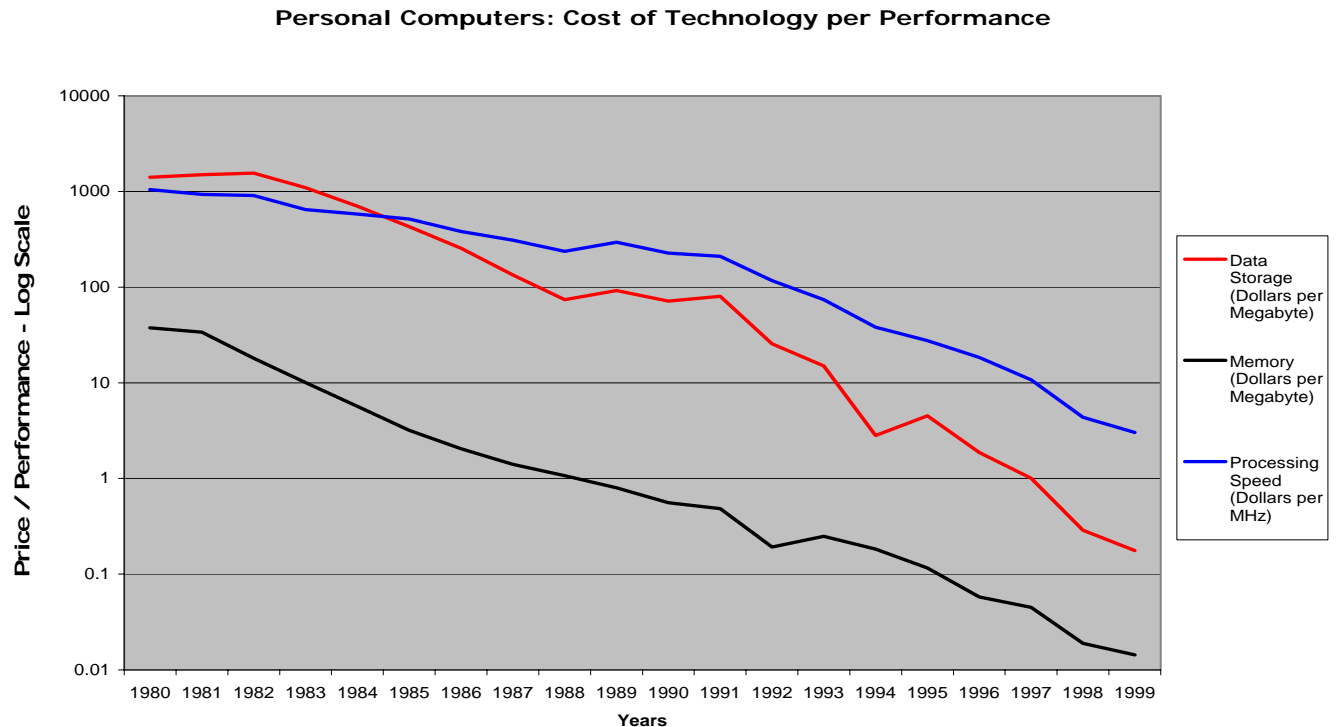


Figure 1. Declining cost of IT performance⁸

These data tell us that annual percentage increases in IT performance per dollar range from an impressive 50% for processor speed to an astonishing 500%—per year!—for information storage over two decades. This trend has yielded cheaper and better IT products, systems, and services, as well as cheaper and better products and services that incorporate IT. For instance, digital camera performance (measured in pixels times number of frames) that cost \$2,000 in 1997 can be bought today for \$1.⁹ The drop in the cost of processing power is especially important for complex systems of all kinds, including military systems, which are stuffed with processors.

The notion that such IT developments have produced a new economy has been advanced by no less an authority than then-Federal Reserve Chairman Alan Greenspan:

“[T]he development of the transistor after World War II appears in retrospect to have initiated [a] wave of innovative synergies. It brought us the microprocessor, the computer, satellites, and the joining of laser and fiber-optic technologies. These, in turn, fostered by the 1990s an enormous new capacity to disseminated information.... [I]t is information technology that defines this special period. The reason is that information innovation lies at the root of productivity and economic growth.”¹⁰

⁸ R. Berndt, Ellen Dulberger, and Neal Rappaport, “Price and Quality of Desktop and Mobile PC: A Quarter Century of History,” July 17, 2000

⁹ Mega pixels have increased over one hundred-fold, and numbers of frames by as much as two hundred-fold.

¹⁰ Remarks by Federal Reserve Board Chairman, Alan Greenspan in a speech before the Economic Club of New York on January 13, 2000 in New York City.

The pervasive exploitation of IT and sharp improvement in price-performance have indeed already had wide-ranging economic benefits: rising domestic labor productivity growth; revolutionized production processes; innovation stimulus; better management; higher quality; lower cost; the ability to use distributed, remote, and lower-cost (often overseas) labor; rapid innovation; the advent of “learning” organizations; intensified competition; and more transparent markets. As a result, civilian economic sectors with large IT content are delivering either the same service at lower cost (e.g., lower airfares), improved service at level cost (e.g., distributed banking and distributed training) or, best of all, declining cost for more service in sectors where IT content is especially high (e.g., telecommunications and entertainment). Suppliers have not always benefited; the airline industry has been squeezed between Web-empowered customers and cut-rate competitors, and competition has forced telecommunication service providers to pass on to customers the savings from declining IT costs. But customers are getting more for less.

Why is this not happening in defense? To restate the puzzle:

- If the price-performance of IT is improving dramatically, which it *is*,
- and the amount of IT in military capabilities is growing rapidly, which it *is*,
- then defense should be able to get greater capabilities at a lower cost,
- which, as far as we can see, it *isn't*.

If defense would begin moving toward a more economic cost structure with better price-performance in its capabilities, more resources could be spent in other areas, such as readiness, research, recruitment, and retention. Think of an elementary model of total military capabilities in which there are only two factors: technology and people.¹¹ The cost of people is rising (say, 5% annually), as defense must compete for skilled and educated people with high-paying career alternatives. But the cost of technology—especially the dominant technology, IT—is, as noted, dropping precipitously.¹²

At the same time, the mix of factors in this simple model (and in reality) is shifting from people-heavy to technology-heavy—a consistent pattern of the IT economy. In fact, the number of people in the U.S. armed services has declined from 1.4 million to 1 million in the last ten years, and the amount of IT clearly has grown. While it is surprisingly hard to determine the IT value of defense spending—something DOD might wish to track—spending on intelligence and communications, both heavily IT-based, may be used as a proxy. Such spending has increased over the same period from about 9% of total defense spending to 14%. Granted, not all DOD investment in intelligence is IT. On the other hand, this is easily offset by the swelling IT content of all sorts of weapons and platforms, which is largely ignored in the measure of spending on intelligence and communications. On the whole, this seems to be a conservative estimate of the growing IT content of defense.

Thus, the high-cost factor in the two-factor model has been shrinking while the low-cost factor has been growing. This means that the total cost of defense capabilities, for a given set of requirements, *should* be dropping. This is clearly not the case. Indeed, as we shall see, the incorporation of IT into

¹¹ The factors ignored in this model—real estate, metals, fuel, other commodities, etc.—are important, of course. However, their costs seem to be relatively stable (except for fuel), and their role in defense performance is certainly not growing, and is perhaps shrinking.

¹² Of course, IT is not the only technology on which defense relies. However, it is the technology the role of which is growing the fastest and is generally most important in recent performance improvements.

defense capabilities may actually be *increasing* total costs, defying larger economic trends and basic economic reason.

This is, needless to say, not to argue against shifting the defense mix toward IT.¹³ After all, the United States is unrivalled in IT-based innovation, and it is better off stressing personnel quality over quantity. Even with force transformation still young, IT is one reason that U.S. forces are unrivalled in combat. IT is at the core of force transformation: precision guidance, detection and tracking, shared situational awareness, just-in-time logistics, cooperative engagement, and joint operations. And of course, IT is the essence of net-centric warfare.¹⁴

Once again, the expansion of IT in defense is not only from the greater use of computers and networks but also from the growing IT content in platforms and weapons. For example, the IT content of combat aircraft has increased significantly in the past several decades. Using lines of software code as an indicator of IT richness, the Joint Strike Fighter (JSF) has about 6 million lines, compared to about 1.6 million for later versions of the F-16—a 375% increase.¹⁵ An estimated 60% of the cost of the F-22 is IT.¹⁶ Such growth in IT content provides a hint of the opportunity for controlling if not reducing the cost of defense capabilities *if* DOD can learn how to exploit the declining IT costs that are benefiting the larger American economy.

The problem of rising costs of military capabilities is not confined to combat aircraft. In the words of then-Chief of Naval Operations, Admiral Vernon Clark:

“Among the greatest risks we face is the spiraling cost of procurement for modern military systems, and shipbuilding is no exception. When adjusted for inflation, for example, the real cost increase in every class of ship that we have bought [in the last four decades] has been truly incredible. It becomes more so when taken in comparison to other capital goods like automobiles, where the inflation-adjusted cost growth has been relatively flat over the same period of time....As we seek greater combat capability and greater operational efficiencies through upgraded power, propulsion, *and computing technologies*, we find a ratio of *cost growth beyond our seeming control*, which may not be fully explainable solely by reduced economies of scale.”¹⁷ (Italics added)

¹³ Shifting the defense mix toward technology has implications for personnel. Quality becomes increasingly important and numbers less so. Overall, an emphasis on technological and personnel excellence should favor the United States.

¹⁴ Paul Bracken, Stuart Johnson, and Linda Brandt have written that the innovative landscapes could be segmented into products, processes, and retrofits of legacy systems. Paul Bracken, Linda Brandt, and Stuart E. Johnson, “The Changing Landscape of Defense Innovation,” *Defense Horizons* 47 (Washington, DC: Center for Technology and National Security Policy, July 2005). Similarly, military IT could be split into network-centric systems, processes, and off-the-shelf products. Increasingly, DOD does not need to develop its own IT processes. Also, DOD buys large quantities of standard computer and IT products off the shelf. In regard to network-centric systems, integration and complexity are problem areas that appear to contribute to high cost. This framework suggests that DOD can pursue IT economies in different ways, depending on the segment.

¹⁵ Chris McGee, Aeronautical Systems Center, Office of Public Affairs Wright-Patterson AFB, Ohio. Donald Gary Van Oss, “Avionics Acquisition, Production, and Sustainment: Lessons Learned—The Hard Way,” NADIA Systems Engineering Conference, October 2002.

¹⁶ Obaid Younossi, David Stern, Mark Lorell, and Frances Lussier, “Lessons Learned from the F/A-22 and F/A-18E/F Development Programs” (Santa Monica, CA: RAND Project Air Force, 2005) 31.

¹⁷ Statement of Chief of Naval Operations Admiral Vernon Clark before the Senate Armed Services Committee on February 10, 2005, Washington, DC.

The cost of submarines, for example, has more than doubled in constant dollars in the last twenty years, during which time the technology content, including IT, has grown.¹⁸ The cost of IT-rich, complex, non-military systems has in general experienced no such growth. For instance, the average constant-dollar cost of Boeing's commercial aircraft has been virtually flat over the last ten years, though their performance has improved markedly.¹⁹ Some non-military systems with especially heavy IT content, such as telecommunications systems, have declined in price. Even automobiles are becoming more IT-based and less costly; the real cost of an S-Class Mercedes has declined by 30% in the last ten years, as the IT content has grown to 30% of total value.

Of course, price-performance matters more than price. Indeed, the benefits of IT in the economy as a whole are the product of stunning increases in performance at stunningly lower costs. In contrast, performance increases in military capabilities, owing largely to IT, are accompanied by cost growth.²⁰ It seems that the gains in price-performance of IT vanish by the time the technology finds its way into defense capabilities.

For instance, the performance of combat aircraft has improved with increased use of IT. Using one accepted metric for air-superiority combat—"kill ratio"—it is estimated that the performance of the F-22 is 5 times greater than that of its predecessor, the F-15.²¹ That improvement can be attributed in large part to the F-22's IT-rich "integrated avionics suite."²² However, better performance has been expensive. The 1981 price (in 2005 dollars) of an F-15 (predecessor of the F-22) was \$60M; the price of an F-22 is \$260M. Thus, largely *because* the F-22 has much more IT content than its forerunner, it performs 5 times better.²³ Yet, *despite* the declining cost of IT in the general economy, the cost of the IT-packed F-22 is over four times greater. By this particular measure, the performance per dollar of U.S. air-superiority fighters has been more or less flat over two decades, notwithstanding growing IT content.

To be fair, the price-performance of individual military systems may understate the price-performance of U.S. military capabilities as a whole, for two reasons. First, entirely new types of systems have appeared that add significantly to overall performance, precision-guided munitions (PGMs) and UAVs being prime examples. Both contribute greatly to overall performance, and both are increasingly economical. Indeed, ingenuity in applying IT can have large price-performance effects even in defense. While very expensive at first, PGMs now provide greater precision at lower cost because expensive on-board guidance has been replaced by connectivity to off-board navigation systems (i.e., global positioning). Second, networking permits "systems of systems" to perform better than the sum of the constituent platforms, weapons, and sensors. Of course, IT has been crucial in this respect, too. So it is possible to get more for less in defense. Unfortunately, in order to obtain better performance in major platforms, still the bulk of military capabilities and investment, defense customers are forced to pay more.

¹⁸ Ibid.

¹⁹ Data from Boeing

²⁰ This phenomenon is certainly also present in the cost of naval surface ships and submarines. Most of the rise in cost of naval systems is attributed to an increase in complexity and capabilities, even though that increase is in part the result of incorporating more IT. The relentless growth in ships is one reason why the Navy's fleet is shrinking and why its future shipbuilding requirements appear unaffordable.

²¹ Donald Sevens, John Gibson, and David Ochmanek, "Strategic Appraisal: United States Air and Space Power in the 21st Century," (Santa Monica, CA: RAND, 2002), 85-141.

²² Younossi et al., 4.

²³ Stealth and advanced propulsion are the other factors in improved performance of the F-22 compared to the F-15.

The question of price-performance of military capabilities is an abstruse one, especially when taking into account changes in the threat, such as improved enemy air defense and anti-ship missiles. We readily admit that more analysis is needed to go beyond the approximations and illustrations provided in this exploratory piece. Yet, we stand by our central point that the total cost of the Nation's increasingly IT-based defense capability is rising relentlessly despite sharply improved IT price-performance.

If defense price-performance approximated that of other IT-reliant sectors, national military capabilities would be improving many times faster than costs. To illustrate, if the price-performance of combat aircraft were improving at a mere 1% of the rate of improvement in price-performance of the typical civilian IT products, the F-22 and JSF would cost *less than* their predecessors, not many times more. If this example strikes the reader as preposterous it is because we have been inured to the seeming inexorability of cost growth in military systems, in contrast to non-defense systems.

Let's take a more conservative case. Assume that the performance of air-superiority aircraft has increased five-fold over the last twenty years and that the performance of high-end commercial aircraft has merely doubled over that same period. (This is roughly borne out by the data.) Recall that constant-dollar cost growth of commercial aircraft is essentially zero. It follows that if the rate of improvement in price-performance of air-superiority aircraft were the same as that of commercial aircraft, the F-22 would cost about \$150m, not \$260m. Accepting its assumptions, this illustration begs the question why prices of IT-rich military systems are growing much faster than those of IT-rich non-military systems.²⁴ Also, it suggests that discovering the reasons why defense remains outside the real economy could have enormous impact.

²⁴ Much as we would like to, we cannot offer an estimate of total defense savings if the defense sector enjoyed the same "IT economics" as the economy at large, for several reasons: no one seems to know how much DOD spends on IT, if the huge and growing amount embedded in larger systems is included; there is no data or estimate of trends in price-performance or productivity of defense as a whole; compiling price-performance for all relevant non-defense IT-rich capabilities would be monumental, if not infeasible.

Alternative Explanations of Why Defense is Outside the New Economy

Why *does* the defense sector defy the new IT economics? This is not an academic question; it has strategic significance. Cost pressures on the Pentagon are enormous and growing, and a gap between needs and capabilities looms. IT offers a technological-economic strategy for national security in the 21st century, much as aerospace technology did in the last half of the 20th century. IT provides a strategic option that does not depend on simply shoveling national resources into defense, which is hardly strategic. The ultimate value of any technology lies in its price-performance results. To ignore this would be like drawing up strategy but ignoring the economics of industrial mobilization in World War II or the economics of nuclear deterrence in the Cold War. Just as these were “core competencies” of American power then, IT is now. We need to understand the economic relationships of technology, economics, and grand strategy or we will badly misallocate capital, as the Soviet Union did. Accepting the status quo has strategic consequences, as Soviet leaders learned the hard way.

Let us now turn to our four hypotheses to explain the stubborn resistance of defense to the general economic gains of the Information Age:

1. It just takes time. The cost of defense capabilities will begin falling some day, as more use of IT, competition in outsourcing, and organizational learning take effect.
2. Defense is different. Incorporating IT in defense systems is not like buying a PC or ATM; it has unique and extreme application environments, so it naturally costs more.
3. It's the bureaucracy. Congressional mandates, government acquisition regulations, bureaucratic processes and staffs, and the propensity of the services to change their minds about what they want keep costs rising. Eliminate these and we could save a great deal.
4. The structure of the defense industry is thwarting economies from IT. Defense firms are rationally pricing IT-based military capabilities at high cost given their business models, the competition they face, their strong position in the acquisition process, and their decoupling from the general economy.

Depending on which of the alternative hypotheses one accepts, solutions to the problem of defense economics, and thus grand national strategy, will vary fundamentally.

1. It Just Takes Time

We know from a quarter-century of experience with institutions of all sorts that structures, culture, processes, and operations must change to realize fully the promise of IT. IT alters how people and organizations work. This is never easy or quick. Research on the relationship between investment in IT and productivity improvement in the corporate sector confirms the need for time to reap the benefits. This holds true at the macro level of the U.S. economy and at the micro level of the firm. One measure widely taken as evidence of a new economy is productivity growth in the U.S. economy. Yet such change takes time; major productivity improvement only began to appear in the mid-1990s, after a decade of heavy IT investment and only modest gains.

At the level of individual non-defense companies, studies show that while investment in IT pays off with some immediate productivity increases, this effect is dwarfed by longer-term benefits. Two- to five-fold productivity increases came anywhere from 2 to 7 years after the initial IT investment.²⁵ The explanation for this is that an organization investing in IT needs time to develop and exploit productivity-enhancing virtues. Changes like automation of routine tasks, decentralization, distributed production, improved asset management, better information flows, and training take years. Cultural adaptation can take a generation.

Compared to major commercial sectors, defense was late in investing strategically in IT, especially in the technologies of distributed processing that have propelled the information revolution since 1980 or so. Moreover, its complexities, extreme circumstances (such as combat), lengthy procurement cycles, and institutionalized conservatism cause defense to change more slowly than other sectors. By this reasoning, DOD will yet reap dramatic economic benefits from IT down the road, as the problems of adaptation that delay savings will be eliminated in the next few years. What is needed, in this view, is not remedial action, but patience.

It is true that there will be a time lag in defense; regardless of sector, investment in IT must be sustained over some time before it can pay off on a strategic scale. However, in other sectors, the pattern has been for modest but noticeable economic gains to occur right away, followed by much larger ones years later. In defense, we have not seen general economic gains, even though it has been ten years or more since defense began to invest heavily in IT. On the whole, the improvement in defense capabilities owing largely to IT has been attended by increased cost. This could portend that there are no major economic gains on the way. Why should we think "it just takes time" when the results so far violate the economic pattern found in the commercial realm?

Moreover, the investment-productivity time lag does not explain why increased IT content is not yielding more or less immediate reduced price or improved price-performance of specific defense systems, the costs upon delivery of which should not depend on sweeping organizational reform. System costs have climbed, not fallen, as IT content has increased. There are some examples of quick economies, UAVs and PGMs being the most important. However, major platforms tend to become more expensive not only from one generation to the next but within their own lives. The acquisition cost of a JSF, an IT-loaded airplane, has grown from \$30M per copy to \$60M in constant dollars since 2002.²⁶ Even more telling, the costs of the F-22's avionics controls, displays, and core processors have grown in real terms by 35-47% in the past seven years, even though the cost of IT in the other sectors and complex systems has plummeted in that same period.²⁷ There is no sign of a trend shift in other programs either. The DDX, CGX and other IT-loaded systems are experiencing cost escalation comparable to the JSF.

"It just takes time" is worse than an invalid hypothesis; it is a dangerous one because it pardons complacency. From the economic data and reasoning offered here, it appears likely that more cost growth, not gains in productivity and price-performance, are in store for defense, unless something is done other than waiting.

²⁵ Erik Brynjolfsson and Lorin M. Hitt, "Computing Productivity: Firm Level Evidence," MIT Sloan School of Management, Working Paper 4210-01, June 2003.

²⁶ United States Government Accountability Office (GAO), Report to Congress (GAO-06-271 "Opportunity to Reduce Risks in the Joint Strike Fighter Program with Different Acquisition Strategy" (Washington, DC: United States Government Accountability Office, March 2005).

²⁷ Younossi et al., 32.

2. *Defense is different*

In this explanation, widely held by military professionals, defense is a buyer of very complex special-purpose systems intended for unusual and extreme operating environments. Defense requires sophisticated capabilities not needed in the commercial sector: speed, survivability, performance range, redundancy, and electronic hardness. Military performance, durability, and other standards are more demanding than are standards for civilian systems. Moreover, defense must build for the most intense conditions it may face, where time and risk are highest, whereas in most non-defense fields it suffices to build for the ordinary and hedge for the most intense.²⁸ All of these factors add to costs. They also add to complexity in design, production, operation, and maintenance, which in turn adds more to costs. The defense-is-different mantra is that military *capabilities demand complexity, and complexity adds cost*.

Furthermore, there is no market for defense systems in the non-defense world.²⁹ Being unique and bought in relatively small numbers, military systems do not offer economies of scale in production. This is true for non-IT and IT content alike. To the extent that its computing and communications requirements are special, defense cannot take advantage of the economies from commercial IT standards. In this hypothesis, such factors wash out the productivity gains from IT found in the rest of the U.S. economy; unique and exceptional performance is required, and higher costs must be the accepted norm for defense IT.

If true, this hypothesis is especially chilling. If potential IT-related savings in military capabilities are negated by defense-specific factors that increase costs, it implies that IT *cannot* improve price-performance in the defense sector. In other words, the nature of defense is such that there is little opportunity to align national technological-economic power to national strategy. If IT is not the answer—if we are deluded by the promise of improved military price-performance—it means that we are condemned to pay more and more to meet flat or increasing defense requirements, or that defense spending may not decline even if requirements do. If such implications are dubious, so is the hypothesis itself. Surely defense productivity, while disappointing compared to the economy at large, is greater than it would be if defense did not exploit IT in its capabilities and instead bought more platforms and mechanized gear.

We suggest a different analysis which casts doubt on the hypothesis. Granted, defense is different. Building an Army mobile command and control network based on cellular technology is different than buying civilian cell phones and opening an account with Cingular. For one thing, the cell towers have to move with the Army (to locations unknown); in the civil case they are fixed and need no protection. But this example belies an important management issue. While it is correct that defense has special needs, the core information technologies—processing, memory, storage, search engineering, automation, micro-systems, computer-aided design and engineering, display, fiber optics, cellular and satellite communications—come from larger civil markets and R&D, yet are of value to defense and non-defense alike. Again, the underlying IT being used in defense is essentially the same as that which is experiencing phenomenal price-performance improvement, as

²⁸ It is also argued that where national security is involved, as opposed to profitability or share value, price is less important, which may account for defense being less insistent on affordability. However, with limited resources available for defense, spending too much on one capability implies spending too little on another; therefore, defense ought to be as price-conscious as any other endeavor consuming scarce resources.

²⁹ Throughout this study, we ignore non-U.S. defense markets, which are too small to affect the analysis.

shown earlier. The cost of defense IT comes from the *adaptation and integration* of these technologies into specialized military systems. Yet, defense adaptation is not so extreme, so massive, or so different that it would explain, let alone justify, such sharply divergent cost trends as a nearly 50% growth in the cost of the F-22's data processors over a period during which the per-dollar performance of data processors in general has increased by roughly 1000%.

Moreover, the added burden and cost of adaptation and integration is present in all sectors that make heavy use of IT, whether defense or non-defense. The complex information systems that control electrical power distribution are different than those that automate car manufacturing and those that enable cellular telecommunications. An insurance company that buys an enterprise resource program (ERP) system to improve productivity doesn't simply get a carton of CDs. It gets the software and then hires an information-systems integrator or consultant to incorporate it and to educate its employees on how to use it.

In this respect, defense is *not* unique, especially when it comes to IT. If it were, the recent (and, in our view, laudable) efforts by defense to make use of commercial off-the-shelf (COTS) IT would make little sense. If defense is really so different, why are military customers flocking to commercial solutions (e.g., Internet-based collaboration and search programs) that were not designed with them in mind?³⁰ Moreover, even though some defense requirements are more stressing than those of civilian applications, this cannot account for the gaping divergence between price-performance improvements in the civilian world and their absence in defense. Is it possible that a JSF costs three times an F-16 because the expense of adapting and integrating IT wipes out the declining cost of IT? If so, is this acceptable?

"Defense is different" is a self-fulfilling excuse that perpetuates poor price-performance and deprives national defense of the benefits of larger, faster, more dynamic, and more inventive IT markets. It condones expensive adaptation and integration services. Moreover, by exaggerating the difficulty of applying IT to defense, this hypothesis legitimizes the ceding of government responsibility. It implies that the challenge of managing, adapting, and integrating IT into military capabilities is so daunting for DOD that it must be left to defense contractors (more on this later).

The larger strategic implications of the U.S. defense establishment not understanding the technologies fundamental to 21st century war-fighting should raise the gravest concerns. It would be like Germany in the 19th century not having people in its general staff who understood everything about railroads, or the United States in the Cold War not having the Los Alamos and Livermore Laboratories working on nuclear weapons, or the U.S. Air Force ceding knowledge of aerospace technology to its vendors.

Apart from differences in technical requirements of defense compared to other sectors, there are cultural differences that may help explain the difficulty in joining the IT economy: the strong aversion to risk, owing to the high stakes implied by national security; a largely career-service workforce, isolated from the larger economy; and a preference for capabilities specified according to defense requirements. While these differences cannot be dismissed, it is not clear how much they contribute to the anomalous economic performance of defense. After all, defense does not pay too

³⁰ The demand of joint component commands for commercial solutions is evident in the growing volume of fast-track acquisition cases and standards waivers.

much for everything it buys. So, cultural factors do not seem to explain why the costs of defense capabilities are especially out of line with comparable civilian capabilities.

In sum, defense *is* different, but so are many other sectors. In any case, defense is not so different as to account for such huge missing economies from harnessing IT—nor so different that DOD cannot manage its application.

3. *It's the bureaucracy*

In this hypothesis, the Federal Acquisition Regulations (FAR), Competition in Contracting Act (CICA), Congressional (political) involvement, and Pentagon bureaucracy obstruct would-be economic gains. This view is widely held, with a certain cynicism if not resignation, inside the Washington beltway.³¹ An acquisition system that already compounds costs and slows development, production and procurement of traditional military equipment is particularly ill-suited for IT and IT-based systems that defense increasingly needs.

To be fair, government procurement should, and inescapably will, be governed by a regime of laws and rules to ensure competition, transparency, and trustworthy stewardship of public monies. Congress mandates these rules. To comply, DOD has erected a baroque acquisition apparatus that eats up time, drives up costs, beats down innovation, and turns off successful companies, including IT firms that do not specialize in defense. This is exacerbated by poor (by business standards) management practices, such as single-year budgeting, rigid requirements and a related tolerance for excessive costs for changes, cost-plus pricing, and programming that nearly always slips and gets more expensive. Making matters worse, having demanded these practices for the worthy purposes of minding tax-payer money and advancing the public good, Congress then injects its own special-interest demands and distortions, often at the cost of cost-cutting.

Apart from communism, it is hard to think of a system less conducive to creating and exploiting the economic dynamism that Greenspan and others attribute to IT. The best evidence for this hypothesis is the ingenious ways military customers—especially those with line operating responsibilities (i.e., combatant commands)—are sidestepping and shortcutting standard acquisition practices and bureaucracy to meet their IT needs.³² At the same time, navigating the intricacies and byways of the acquisition process, like Venetian canals, is a trade of its own. Understanding how to make this system work—steering funding, knowing who to see, shaping programs—is a core competence of “insiders” (in and out of government) and a bewildering puzzle for the uninitiated.

Although the defense firms are acting rationally, given their environment, the same cannot be said for the acquisition system. While explaining why this is so would require a lengthy excursion into the field of institutional psychology—which we have spared the reader and ourselves—at the heart of the problem is that the *whole* of the system does not produce outcomes that its many *parts* are meant to achieve, notably, affordable military strength and a good deal for the tax-payer. The most obvious evidence of the irrationality of the defense acquisition system is that escalating and over-running costs are tolerated even though everyone knows how destructive this is of the values the system exists to serve. The system does not demand lower prices, which are as vital a function as

³¹ Jack Spencer, (ed.), *The Military Industrial Base in an Age of Globalization* (Washington, DC: Heritage Foundation, 2005).

³² Such shortcuts include various fast-track acquisition procedures and waivers to meet operational demands, which are especially and increasingly common in acquisition of IT-based systems.

there is of the demand side of an economy. Such perverse, or at best sub-optimal, effects are the result of reliance on regulation and planning at the expense of economics.

Efforts to overhaul and slash the defense-acquisition bureaucracy as a strategy to reduce costs go back a long way. The 1986 Packard Commission (The President's Blue Ribbon Commission on Defense) and dozens of other inquiries and panels have studied the problem. Some commissions have actually made the problem worse by advocating buyer-supplier “strategic partnerships,” which have weakened the leverage of defense and increased that of suppliers. In any case, counting on complete overhaul of defense acquisition borders on the romantic. Too many powerful actors—vendors, acquisition bureaucracies, and industrial-political interests—are content with, or vitally dependent on, the status quo.

But IT is a major new factor, and this is not appreciated enough. IT development cycles run a year or less. Streams of new products and services are available continuously. Software releases permit significant improvements in place. Knowing this, IT users are quickly dissatisfied; their growing, changing, pressing needs are what drive the fast pace. The best IT solutions, and the strongest IT companies, are those that sense changing user needs and respond without delay. A regulated acquisition system designed to buy large, discrete military-specific “things” that change according to plan every decade or so is going to be incapable of exploiting IT. Conversely, such a system will make it impossible for defense customers to get what they need when they want it from fast and fluid IT markets. One reason military operational commands are bypassing the normal acquisition system, using formal waivers, informal shortcuts and admirable trickery is that it adds both time and cost. One reason IT firms do not participate in the defense systems market is that it is the antithesis of the unregulated world on which their business model is based and which their people know and like.

We wish we could reject “it’s the bureaucracy” but we can’t. Recent research shows that defense exploitation of IT is hampered by oppressive rules, regulations, habits, and infrastructure of the acquisition system.³³ It is said that the avionics for the F-22 was “obsolete before the plane even went into production” because the chips in the processors were already a decade out of date (therefore more expensive), compliments of your friendly DOD acquisition system.³⁴ There are wider implications of such under-achievement that no one wants to face. DOD is likely to fall far short of potential in fields and missions that demand the latest IT systems and know-how, e.g., information warfare, mobile communications, and intelligence. And it will face a future of unalleviated cost overruns of the sort it has suffered on platform programs like the A-12 (canceled), the F-22, the JSF and the DDX.

Ironically, savings in defense capabilities could become even more elusive with the advent of IT. Such a perverse possibility follows from our argument that, as the defense value chain shifts to IT, and away from platforms, the costs imposed by a platform-oriented acquisition system will climb and because defense is not a smart buyer of IT. Moreover, the management effort required to

³³ Franklin Kramer and Stuart Starr, “Actions to Enhance the Injection of Commercial Information Technology (IT) in Department of Defense (DOD) Systems,” Center for Technology and National Security Policy, 2005
David Gompert, Charles Barry, Alfred Andreassen, “Extending the User’s Reach: Responsive Networking for Integrated Military Operations,” *Defense & Technology Paper 24*, (Washington, DC: Center for Technology and National Security Policy, February 2006).

³⁴ Younossi et al., 42.

translate IT from its natural markets into the inhospitable defense market will add costs. While the public will pay—is paying—this cost, the effort will be made mainly by the defense industry, which has over the past decade diverged from the IT industry (see next hypothesis).

One can be forgiven for being skeptical about the prospects of radical defense-acquisition reform. Many good intentions have ship-wrecked on these shoals. Yet, the contradiction between the promise of IT for defense and the existing acquisition system makes the case for reform more compelling and urgent than ever. But that case must include the defense industry, not just the acquisition bureaucracy (read on).

4. The industry structure of the defense industry is thwarting economies from IT

In this hypothesis, the way the defense industry is structured prevents defense from enjoying the economies from IT that are being experienced in non-defense markets. The rising productivity value of IT is either being harvested by the defense industry or lost to its inefficiencies.

Industry structure is the most widely used analytic tool employed to understand business dynamics. Whether computer chips or potato chips, industry structure is one of the most powerful frameworks used to understand what goes on, what the prices and profits are, and how innovation takes place. For instance, the deregulated airline industry has many competitors which can switch routes easily, faces high costs from labor and oil, and cannot raise fares without losing market share to competitors. These factors, along with the new-found power of the Internet-savvy traveler, explain why the airline industry is the way it is (i.e., beleaguered from the suppliers' standpoint but encouraging from the customers' standpoint). They explain why we travelers fly across the country for as little as \$99, while five major carriers are in bankruptcy.

There is one exception to the rule that industry structure is a framework commonly used to understand sector economics: defense. Oddly, industry structure is hardly ever invoked to analyze why things are the way they are in defense. Most studies of defense acquisition offer variations of the first three explanations offered in this paper. A few bring up competition.³⁵ One of the most important findings of research at business schools over the last two decades is that there is more to competition than the number of competitors and the intensity of the rivalry among them. Substitute products, buyer power, the threat of new entrants into the industry, and supplier power are equally important factors in determining competition.

The essence of industry analysis is the relationship of these structural factors, one to another. Again, take airlines. Competition drives down profit margins. But since the cost of going into the airline business is low—it uses borrowed money with the airplanes as collateral—an airline cannot raise prices without attracting a new start-up airline going after its routes. In other words, to understand the industry these two structural factors—competition intensity and low threat of entry—both have to be understood. Analyzing the airline sector using any one dimension alone ("oil is driving up our costs") is very misleading.

The defense industry is highly concentrated in several major firms that control access to customers via prime contracts, shape demand, and are insulated from wider markets. Smaller specialized

³⁵ Jacques S. Gansler, "Next Steps in Defense Restructuring," *Issues in Science and Technology*, Summer 2003, available at www.issues.org/issues/19.4/gansler.html.

defense firms neither put competitive pressure on the major firms nor provide a channel to the larger economy. Leading IT firms, large and small, have mostly elected not to target defense systems markets, mainly because of the regulatory-bureaucratic regime described in the preceding hypothesis. So they are not part of its structure—or, for now, the solution. For their part, the prime defense contractors are not financially motivated, institutionally equipped or market positioned to pass on IT price-performance improvements and cost-saving innovations to defense customers. In this hypothesis, the defense-industrial structure and the behavior that results from it are inimical to the economic gains from IT that the non-defense world is experiencing. We will explore this in depth in the pages that follow.

Merging hypotheses 3 and 4, we have (a) an insular, powerful, and sheltered defense industrial structure that cannot, at least does not, transmit IT-related economies to military customers; (b) an intimidating acquisition system that discourages non-defense firms, including top IT firms, that could bring competition, innovation, and economies; and (c) high and rising costs of doing business in this closed system that are, one way or another, borne by customers (and taxpayers).³⁶ Determining which of these factors accounts for how much of the missing IT economies of defense is beyond our purpose in this exploratory essay. But all of them matter and are intertwined. The starting point for understanding this is a closer look at the defense industrial structure.

³⁶ These rising costs are not being borne by the firms' shareholders, as evidenced by stable earnings and growing share price.

Structural Analysis of the U.S. Defense Industry

Several different industry structure frameworks developed and taught in business schools could be used to understand a sector. We will stick with one of the simplest and most widely taught, Michael Porter's.³⁷ The Porter model of industry structure and competition applies five factors: 1) competitive rivalry of existing firms in an industry, 2) the bargaining power of those suppliers, 3) the bargaining power of buyers, 4) the threat of new entrants, and 5) the threat of substitute products and services. As illustrated by figure 2, each factor affects and is affected by the others. Let's look more closely at each factor and then at their aggregate impact on competition and defense economics.

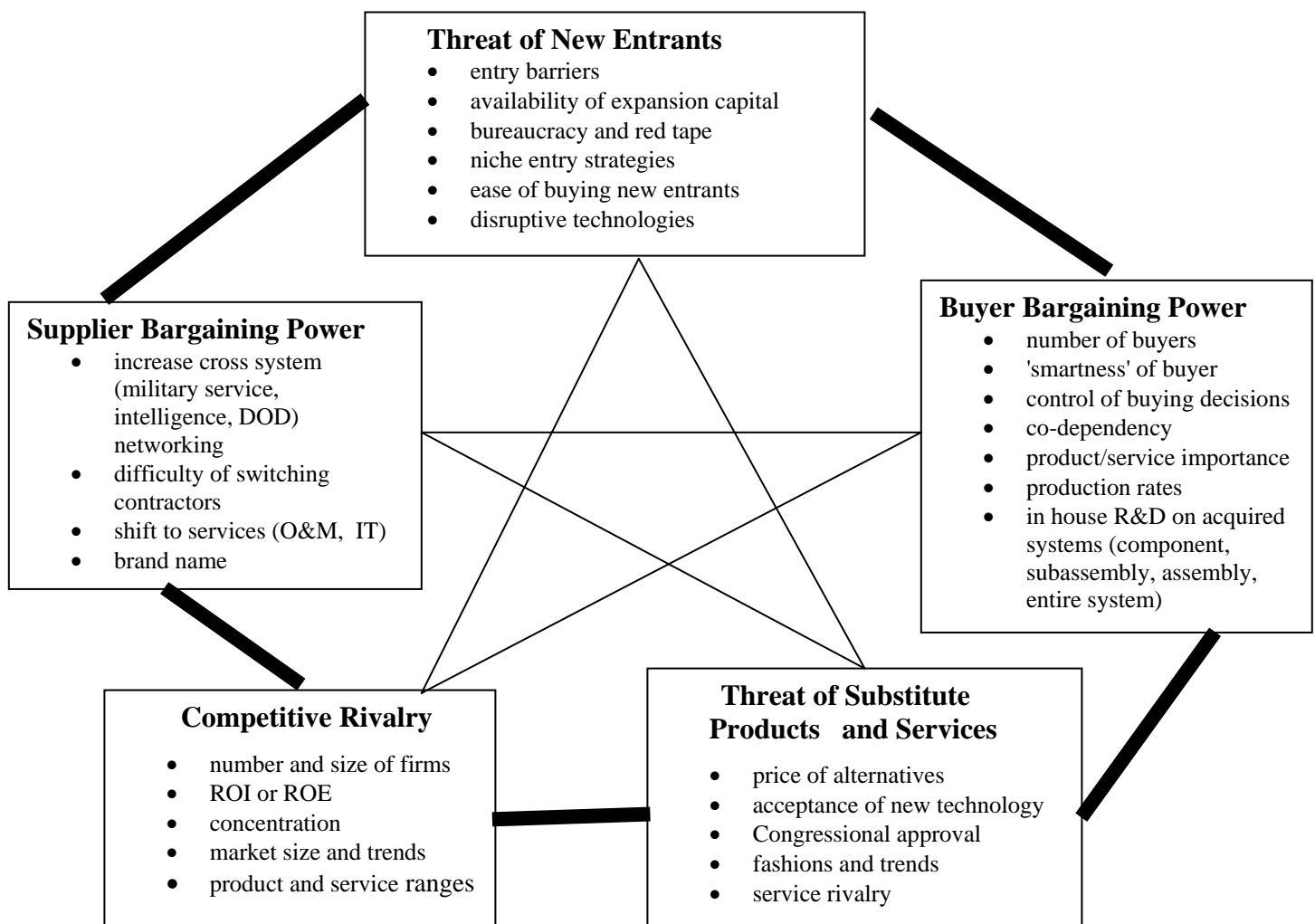


Figure 3. Five Forces of Industry Structure

³⁷ Michael Porter, *Competitive Strategy, Techniques for Analyzing Industries and Competitor* (New York: Free Press, 1980).

Competitive Rivalry among Firms in the Defense Industry

The intensity of competition is usually measured by such metrics as profitability, return on investment or equity, and the number of competitors in the industry. While countless companies do business with DOD, the market for major military systems is dominated by five large firms of roughly similar size (\$20-30B in annual revenue). They are known as lead systems integrators (LSIs) because their main function is to integrate complex military systems and because they alone are considered qualified to lead major defense programs. Their annual revenue since 1996 is shown in figure 3.

	<u>Northrop Grumman</u>	<u>Boeing</u>	<u>Lockheed Martin</u>	<u>Raytheon</u>	<u>General Dynamics</u>
1996	8.6	22.7	26.9	10.1	4
1997	9.1	45.8	28	11.5	4.6
1998	8.9	56.2	26.3	17.3	5.4
1999	9	58	25	17.2	9
2000	7.6	51.3	24.5	16.8	10.4
2001	13	58.2	24	16	12.1
2002	17.2	54	26.6	16.7	13.8
2003	26.2	50.5	31.8	18.1	16.6
2004	29.9	52.5	35.5	20.2	19.2

Figure 3. Total Revenue of the Five Largest Defense Systems Providers (billions of dollars)

With the growing importance of information in military operations and in the IT content in defense capabilities, along with a corresponding decline in the importance and quantities of mechanized equipment (e.g., vehicles, airframes, vessels), LSIs have gone increasingly into systems integration and maintenance services. LSIs integrate disparate IT sub-systems, integrate these with non-IT parts of weapons and platforms and, in turn, integrate these into joint networks of systems.³⁸ They customize solutions to meet special defense requirements, such as survivability and maneuverability. An indication of the importance of the LSIs is that in the past 5 years the defense revenue of the big five has climbed about twice as fast as overall defense spending.

In addition to the LSIs, professional services and consulting firms have significant defense businesses. The defense outsourcing boom of the 1990s, along with the “Bush build-up” since 2001, has drawn many such firms to the sector or expanded their opportunities. Unlike the LSIs, these firms do not make weapons or platforms, and some of them are active in non-defense markets.

The defense industry assumed this general shape during the post-Cold-War decade, as declining demand for military platforms, weapons and other systems precipitated consolidation, with DOD’s blessing.³⁹ In parallel, a number of large technology companies (e.g., IBM, Lucent, Unisys, and GE) shed their defense-systems businesses to concentrate on booming commercial markets. With the

³⁸ See Robbin Laird’s “Transformation and the Defense Industrial Base: A New Model,” *Defense Horizons* 26 (Washington, DC: Center for Technology and National Security Policy, May 2003) for an excellent, if quite sympathetic, explanation of the shifting and expanding roles of the LSIs.

³⁹ DOD management had a direct hand in the post-Cold-War consolidation of the defense industry and, thus, its current shape. The so-called “Last Supper” created conditions in which a series of mergers and acquisitions would pare the number of prime contractors and eliminate uncompetitive capacity.

exception of Boeing, with its commercial aircraft business, LSIs are not heavily involved in commercial markets, which they find too different from defense and thus too difficult to compete in. The non-government business of the LSIs, apart from Boeing, has shrunk from about 10% in 1998 to about 4% today.⁴⁰ Thus, as IT firms have fled or stayed out of the defense market, LSIs have become overwhelmingly focused and dependent on it.

Another way of looking at industry competition is its degree of “concentration,” the fraction of sales controlled by the top firms. Generally speaking, concentration implies reduced competition. The Using the Herfindahl-Hirschman Index (HHI) is a commonly used measure of market concentration, we find that the market for major defense systems went from “moderately concentrated” in 1995 to “highly concentrated” in 2005.⁴¹ This reflects the history of consolidation of the LSIs, their increased preoccupation with defense, the abandonment of the defense systems market by firms with large commercial business, and the inability of defense contractors other than the LSIs to make much of a dent in the LSIs’ position.

This is not to say that competition does not exist among the big LSIs of Defense, Inc. But it does shed light on the nature of the competition. LSIs often go head-to-head for colossal awards. Boeing went directly against Lockheed Martin in the JSF competition. In addition, DOD recently has tended to award all-or-nothing contracts. The loser of the JSF competition got very little. Competition for the initial award can be intense. It resembles a zero-sum game; what one side wins, the other loses. However, after the initial contract has been awarded, the structure of competition changes because the winner locks in advantages that make it difficult for the Pentagon to turn to a different contractor. (Not surprisingly, cost-overruns tend to mount as changes and additions occur beyond initial requirements.) Moreover, teaming among LSI’s means that competition is often limited to only two groups. In some cases, competition is managed so that losers receive consolation business, lest their loss weaken them to the point that competition is further undermined.

There is also competitive pressure on the structure from large consulting firms that do not sell hardware but are able to offer integration services. They could, and sometimes do, act as intermediaries between military customers and systems providers. However, because the acquisition of defense capabilities is so strongly oriented toward big-ticket platforms and other major systems with substantial hardware content, the LSIs dominate the competition for prime contracts and investment spending.

Bargaining Power of Suppliers

The bargaining power of defense suppliers, especially the LSIs, has increased in the last few years. The concentration just discussed contributes to this. With fewer firms to turn to, DOD is compelled to deal with the ones that can deliver. As noted, because DOD knows that further consolidation and concentration would be deleterious, even the comparatively weak ones can be confident of work.⁴² And because all but one of the LSIs have little non-defense business, their viability depends on getting a “fair share” of defense business, adding to their leverage.

⁴⁰ Even Boeing’s non-defense business has declined from 60% to 40% of corporate revenue in the past five years.

⁴¹ The five largest suppliers had about 85% of the major defense systems market in 1995; share varied significantly among them. By 2005, they had virtually all of the major defense systems market and roughly equal shares—thus the “highly concentrated” rating.

⁴² This is especially prevalent in shipbuilding.

As military capabilities become more joint and less service-specific, owing in large part to the introduction of IT and networking, the power of the LSIs vis-à-vis customers, as well as potential competitors, grows. The existing acquisition system is based on the outdated premise that the individual services have separable demands. It is therefore unsuitable for acquiring cross-service, or joint, capabilities. Consequently, the LSIs can serve their clients by providing what is called “system-of-system management.”⁴³ While such a function is so critical to defense that the military or government servants should perform it, they cannot, at least not without heavy reliance on an LSI. Moreover, small defense firms lack the brand name credibility to do it. (It is like buying office software; if you buy from Microsoft you will not be fired if it does not work, but if you buy software from an unknown startup, you might get into trouble if things go badly.) In addition, non-defense IT firms could provide such IT services to defense. System of system management is, in effect, a new product line of the LSIs—and only of the LSIs—which adds to supplier power. The move to systems-of-systems capabilities has also rewarded companies with breadth and experience across different types of military systems (e.g., sensors, aircraft, and networks)—again, the LSIs. The growing emphasis on networked capabilities has meant that LSIs resemble the systems they are tasked with tying together, creating a new kind of portfolio of defense programs containing big intelligence, aircraft, missile, and ground-warfare programs in each company. This helps makes them indispensable to military customers, who do not have the flexibility to organize themselves in such a fashion.

Yet another contributor to the bargaining power of suppliers is that the cost to customers of switching suppliers grows with higher degrees of complicated IT and systems integration in them. It was comparatively easy for the Air Force to abandon the B-70 program when cost growth outpaced the payoffs from this airplane. The Air Force switched to other bomber programs, ultimately the B-1B and Stealth B-2 bombers. But switching suppliers for systems of systems entails a lot more cost and delay. Thus, the high levels of interdependence entailed in systems of systems increases the bargaining power of firms that can produce them.

The power of LSIs has also increased due to their creeping integration into the defense value chain. Defense companies increasingly make their profits not on hardware sales, but on services contracts to manage, operate and maintain what they have already built. Having designed and built complex systems, they naturally have a major advantage in getting the contracts to service them, e.g., upgrading the software and running the training programs that show the military how to use them. It is much more difficult for the armed services to operate a complex satellite reconnaissance system for joint missions than, say, a new tank. This leads to an important finding: *as the amount of IT increases in defense systems, the bargaining power of suppliers increases*. One limit on the potential of LSIs to dominate the value change is that consulting and other non-hardware firms are capable of providing similar services.

⁴³ Laird in describing Lockheed-Martin’s role in JSF.

Bargaining Power of Buyers

The Pentagon is the sole buyer of military systems in the United States. In theory, concentrated buyer-power can have enormous economic advantages. But, in this case, it can be weak in practice for several reasons. The buyer might not be a smart one or be properly organized to bring its superior power to bear. There are examples of concentrated but weak buyer power in business. In the 1970s and 1980s, Detroit's "Big Three" didn't have purchasing departments organized to exploit the economics of their suppliers and as a result were highly inefficient in this area. It was only in the 1990s that they learned Japanese sourcing tactics, and as a result have gotten much better at managing their supplier network efficiently.

Outsourcing much of the management of acquisition lowers the bargaining power of the buyer, especially if it is turned over to the suppliers. LSIs have considerable influence over buying options and choices for the Pentagon, even more so with IT-based complex capabilities than with mechanized systems that military customers understand better. While regulations can partly offset this tendency, in reality a much more important dynamic takes hold. The more complex the market, like IT, the less likely regulation-based compliance is to work. Any skill that is not exercised is bound to wither. This is no less true of management than anything else. The reason that a GE or a Goldman Sachs is a smart buyer of IT systems is that it does it for itself. They train their own in-house experts and pay them well because IT is so central to their operations and so vital to their success. Of course, both of these companies outsource a great deal of their processes. But they do not turn critical decisions over to outsiders. While DOD may look to consulting firms to serve as intermediaries—perhaps more independent than LSIs because they have no hardware to sell—this can reduce the power of the major suppliers without necessarily increasing buyer power.

Increasingly, LSIs enjoy privileged relationships—"partnerships"—with defense customers in designing architectures, defining requirements, obtaining funding, establishing options, managing projects, and navigating the acquisition process.⁴⁴ In the words of a general officer overseeing a major program, "The LSI is definitely involved in every aspect of this program ... assisting with requirements-development...[and] the integration work that is associated with formulating an acquisition strategy."⁴⁵ Such partnerships are obviously more convenient than arms-length relations. But they do not take into account the concentrated structure of the industry, the power of suppliers, the barriers to entry, or the "co-dependence" its defense customer-partners can develop.

An additional factor leading to lower bargaining power for DOD is that its own technology research arms have turned away from system-wide or mission-wide problems to pursue advances at the component or sub-assembly level. DDR&E and DARPA at one time focused on system-wide problems, e.g. studies of the best mix of nuclear bombers and missiles. In recent years, they have concentrated on things like quiet helicopters, nanotechnology, and faster computing algorithms. When these research organizations perform research on complex computer networks they tend to neglect issues of management and technology insertion into existing complex systems.⁴⁶ This work is important, but it does not help DOD strengthen and exercise its buyer power to understand the economics of its suppliers, the way Detroit began to do in the 1990s.

⁴⁴ Several commissions have advocated this sort of partnership between defense contractors and customers.

⁴⁵ Laird.

⁴⁶ Bracken et al.

The Threat of New Entrants

Potential new entrants to the defense industry face significant problems. Indeed, this is another important conclusion: *What first appears to be mere bureaucracy and red tape is actually a deterrent to entry.* In this sense, hypotheses 3 and 4 are connected and synergistic; the acquisition system reinforces the industrial structure, and the industrial structure enables the system.

Contracting practices based on the FAR are a good example of this. At one level, they are fraught with inefficiencies that add cost and delay innovation. Yet, looked at in terms of competition and industry structure, the system is a powerful deterrent to entry. Firms that have mastered its intricacies would not want to reform the contracting system for two reasons. First, reform would attract new firms into the industry, which would increase competition. Second, the mastery of the maze has become a core competence, like knowing how stealth technology works.

Nevertheless, barriers to entry are not insurmountable. As already noted, major professional-services firms with business in defense and civilian markets can fairly claim to provide service that the LSIs wrap into their prime contracts. More fundamentally, the tremendous vitality of the U.S. economy, with its venture-capital and private-equity industries means that fresh capital is being deployed into innovators with potentially disruptive effects on the existing industry structure. This happens all the time in business generally, and it has happened before in defense. Venture capital played a major role in funding photographic reconnaissance and in standing up the Itek Corporation in the 1960s.⁴⁷ New niche players are coming into defense all the time in specialized areas—often intelligence systems—where technological advantages and narrow or new market space give them an edge over less agile companies.

Under the right conditions, the technological dynamism of the American economy could threaten the dominant position of existing LSIs. While no new entrant may be able to enter this business at the large prime-contract end, where only LSIs tread, they certainly could enter it by competing with better technology or by introducing a new solution at lower tiers of the sector. They could then use their niche as a beachhead to attack the market share of the LSIs, as happens time and again with so-called disruptive technologies.

Of course, the LSIs could acquire the smaller, more dynamic defense firms. Such firms often position themselves to be bought by LSIs, yielding lucrative paydays for managers and owners. But this is a tricky business, especially when small and big corporate cultures clash. It is far from clear that the existing LSIs excel at the corporate acquisition game. Harvesting the knowledge of an acquired firm and integrating it corporation-wide is extremely difficult, even for the very best managers in the commercial sectors. GE does it well, but even such stalwarts as IBM have struggled, and it all but did in AT&T. Moreover, the acquisition of smaller defense firms by LSIs produces no obvious economic gains for national defense.

In any case, as noted, most smaller defense firms also work predominantly in defense, or at least government, work. Therefore, like the LSIs, they are unable to bring technological innovation, price-performance enhancements, and market forces from the larger economy for the simple reason that they are not in it. And although they can put modest competitive pressure on the big defense firms, at least in the niches they find, they are not considered qualified to prime mega contracts.

⁴⁷ Jonathan E. Lewis, *Spy Capitalism: Itek and the CIA* (New Haven: Yale University Press, 2002).

Threat of Substitute Products

This factor is closely related to the threat of new entrants. It is a potentially powerful force for change. In due course, the biggest threat to the F-22 is not the JSF but the unattended combat aerial vehicle (UCAV). In the same way, the biggest threat to the Crusader artillery was not improvement of the Army's 155 mm but PGMs from aircraft. In each instance, a substitute product, perhaps one from a different service, could do a better job. In both case, IT and networking were critical in permitting old molds to be broken—revealing not only the technical but also the economic potential of the technology, if given the chance. The opportunity for product substitution is crucial to progress; in defense, it is crucial to transformation.

This issue goes to the heart of the argument for exploiting IT in defense, given its importance in the horizontal integration of U.S. forces, the vertical integration with national intelligence, and the innovative ways of overcoming operational challenges by networking capabilities. IT can substitute for mechanized systems by providing otherwise infeasible solutions, thanks to information, networked collaboration, or both. However, without achieving IT economies, transformation is severely limited because it may not offer superior price-performance. Moreover, other elements of defense-industrial structure—barriers to entry, supplier strength, buyer weakness—mitigate against widespread product substitution. Small wonder, then, that, for the most part, each aircraft, vessel, vehicle, and weapon system is replaced by an updated version of the same product. The momentum path of the defense industry is to reproduce itself, a tendency that Secretary Rumsfeld has noticed.

Potentially, the military services are in an excellent position to imagine substitute products for themselves and for joint combatant commands. They possess operational knowledge that even LSIs, despite all the retired officers in their employ, do not have. The services know what capabilities they need in combat, what the true costs of ownership are, and what substitutes might do a better job. There are major opportunities here to improve defense IT productivity. Again, however, the whole picture of industry structure has to be considered in particular, the excessive reliance of defense buyers on LSIs to shape requirements, define solutions, and manage acquisition reduces the military's ability to demand alternative products.

Consequences

To sum up, when it comes to the effects of greater use of IT in defense, the existing structure of the defense industry provides for:

- limited, managed competition among established prime contractors (the LSIs);
- significant supplier power;
- diminished buyer power;
- antipathy or apathy toward the sector from the best non-defense IT firms; and
- unfulfilled potential for innovative product substitution.

Add to this analysis the fact that the LSIs are neither producers of IT nor involved in larger, competitive, IT-oriented markets, and the result is the failure of defense to realize the economies of the Information Age.

We emphasize that these observations do not imply any malfeasance on the part of defense companies. They are doing what they are charged to do in corporate governance, maximize shareholder value. Given the conditions of their markets and the expectations of Wall Street, they are acting rationally, reasonably, and properly. For example, compared to IT firms, their investment

in R&D is small—about 2% of revenue on average compared to 10% for comparable IT firms—because their business does not depend on it.⁴⁸ They have relatively little incentive to invest in a knowledge-based workforce, arguably the most important resource in the new economy. Because they are not at the leading edge of IT, they are unable and unmotivated to compete with IT firms for the best technologists. For example, even though information search is an increasingly crucial capability for military forces and operations, one IT firm—Google—hires more search engineers than the entire defense industry, by a wide margin. It does not pay for LSIs to compete for top talent in the IT field, even though it is at the heart of military transformation and key to national defense strategy. The defense market does not demand it of them.

As for *their* value-added, the LSIs have been shifting over the years from technology research, development, and production to a variety of technical and management services that afford them steadier revenue and predictable cash flow with diminished capital and scientific requirements. LSIs naturally gravitate toward such services because defense systems are increasingly IT-based, and LSIs are purchasers and intermediaries, not producers, of IT. In turn, of the services provided by LSIs, the value of technical integration—largely software development—of disparate IT systems is gradually declining as standards-based commercial IT becomes more open and connectivity is easier. LSIs now provide more management and marketing service—proposal writing, sub-contractor management, contract administration, project coordination, and even acquisition-system management—and less technical IT integration service. In some respects, the LSIs are paid to provide services that buttress their market position, increase their customers' dependence on them, and deter entry of non-defense firms.

Corporate culture changes have accompanied the shift in the value of what LSIs provide. Personal contacts, marketing experience, lobbying skills, and FAR expertise have increased in importance; hard-science and engineering skills have declined in importance. Given the industry's structure, investment in project management, contract administration, subcontractor management, and marketing abilities makes perfectly good sense for the LSIs.

With high barriers to entry, lack of non-LSI enthusiasm for DOD business, buyer weakness, and client dependence, LSIs have become principal agents for defense customers. In economic theory, principal agents can be exceptionally strong relative to both customers and vendors, which are either satisfied being subcontractors or deterred from competing to become principal agents themselves. Like most principal agents, LSIs can charge sizeable rents, including healthy mark-up of IT subcontractors' content, often combined with deep discounts from subs with no choice but to go through them.

Meanwhile, as noted, defense customers acquire an interest in the economic well-being of these primes, collectively and individually. As one analyst puts it, "The market *supports* defense firms that have predictable and steady streams of revenue from the U.S. Government, and the mega-primes have the flexibility to move within and among programs to provide for financial stability."

⁴⁸ We looked at three IT companies: IBM, Google, and Microsoft. The spending on R&D by each company was published in MIT *Technology Insider*, December 2004

(Emphasis added.) This is evident in the strikingly uniform and stable, though not excessive, operating profits across the major defense firms and across the years.⁴⁹

Ironically, the desire of defense customers and the defense industry to form partnerships has rekindled interest in revising acquisition rules and regulations in order to foster this. While acquisition reform is desirable in principle, it is not clear to us that making the system easier for the principal agents but not easier for outlying commercial firms is good for defense affordability or for national security. Again, the main argument for partnerships is that military customers have come to believe that they cannot cope without the program management capabilities of the LSIs. However, by impairing competition, reducing the incentive of LSIs to participate in the economy at large, off-loading client responsibilities, and increasing client dependence, institutionalizing DOD-LSI partnership could make *less* likely that defense will experience IT-related economies. Rather, what defense customers need to do is exert stronger demand for economic capabilities, take back responsibility for determining their needs, and become smarter in how IT can be applied and integrated to yield new solutions with breakthrough price-performance.

Taken together, the net effects of these conditions are profound:

- DOD is getting less performance-for-money than it could;
- national defense is becoming less affordable; and
- national strategy is disconnected from the country's technological and economic strengths.

Instead of feeding off an economy the productivity of which is climbing, defense is insulated by a growing dependence on specialized defense firms that have little incentive either to pass on economies or to participate in the commercial markets that generate innovation and drive productivity. The rent charged by these principal agents does not necessarily reveal itself as higher profit margins; yet, neither do the costs of doing business in the "world of FAR" necessarily cut into their profit margins. Much of it is buried in costs, including marketing, sales, administration, and compensation, that are built into the prices they charge for the management services they deliver to defense clients in need of those services.

The effects of this state of affairs on the economics of national defense can be illustrated in figure 4, which reduces the content of defense systems to three inputs:

- *LSI services*—systems engineering and integration, project management, subcontractor administration, contract administration, customer handling. These are further divided into *technical* services (e.g., software) and *management* services.
- *IT*—embedded IT systems for sensing, processing, guidance, and communications; subsystems and components, including hardware, software, and maintenance.
- *Other*—frames, propulsion, explosives, and everything else.

The diagrams in this figure are not meant to be to scale but only to illustrate change. (For example, "other" is and is likely to remain the largest component of value and cost.) They suggest changes from "old" to "new" (over, say, twenty years) in both the value and the costs of these three basic inputs. The purpose is to show what can happen as the percent content of IT in defense systems grows and the general market cost of IT declines. Let's assume that:

⁴⁹ With some exceptions, such as write-offs, the operating income of most LSIs is consistently within the 8-12% range year after year.

- total defense-system costs are increasing as fast as performance (i.e., constant price-performance);
- market cost of IT content of defense systems is declining at the same rate as IT in general (on the grounds that the government does not, in principle, pay more than commercial customers for the same IT);
- the performance (or contribution to system performance) of IT is increasing for defense, just as it for all sectors of the economy;
- the requirement for LSI technical systems integration is flat, given the growing connectivity and utility of commercial IT;
- the cost of “other” is flat.

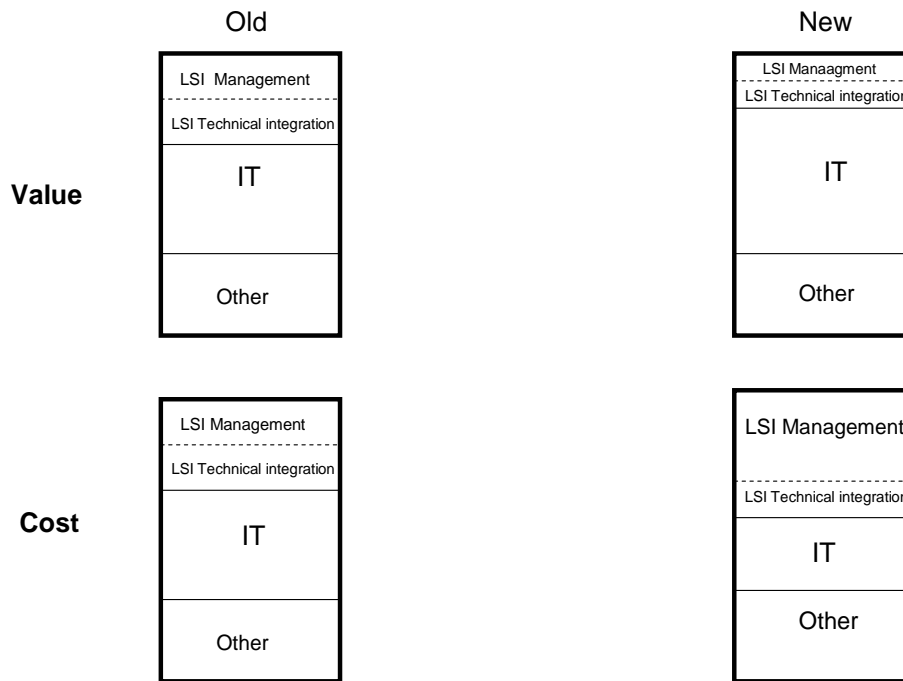


Figure 4. Defense System Inputs

Given the stated assumptions, the value (contribution per unit of cost) of IT has gone up and the value of what the LSIs add—increasingly management services—has gone down correspondingly. Defense contractors and their customers would claim that the value of LSI management services is in fact rising, and in a sense they are right; the difficulties of administering complex programs, especially multi-service ones, in existing DOD “business” processes are undeniable. However, to accept this argument is to accept that the government makes it so hard for the military to acquire defense systems that it must pay rent to those principal agents (the LSIs) whose business it is to help. This confirms our earlier analysis that it is a combination of the acquisition bureaucracy and the structure of defense industry that is denying national defense the economies of IT.

This simple model, with its assumptions, suggests that the real value per dollar spent on integration services is declining at a rate that offsets the increase in real value of IT content. Of these LSI

services, those associated with helping DOD administer complex acquisition programs—i.e., those associated with managing in the FAR environment—are growing, whereas technical services associated with IT integration are declining, for reasons already stated. This begins to explain where the “lost economies” of IT have gone: *to pay for management services that perpetuate and strengthen the existing non-competitive structure at the expense of military customers, defense capabilities, and national defense*. And, as noted, the demand for and cost of these management services could grow as defense needs more joint and IT-based capabilities or IT-based solutions—the two most important emerging types of capabilities—precisely because the FAR system is not conducive to IT and its economies. In other words, the problem could get worse. So much for “just give it time.”

Thus, the high cost of defense is reinforcing an industrial structure that rationally will not, and most likely cannot, pass on the new economies of IT to defense while also serving shareholder and Wall Street expectations. It *will not*, because its business model depends on making money by helping the government apply and integrate IT in the context of a dysfunctional acquisition system; it *cannot* because it is not a part of the commercial IT industry and market that generate those economies. Defense Inc. thus lives in a parallel universe to American business, and its customers and the public are covering the cost of this separation.

It appears that some in DOD are sensing this problem, even if they cannot substantiate it. The Interim Director of the Office of Force Transformation (in the Office of the Secretary of Defense) has asserted in public that systems integration has become a cost that must be reined in. As an example, he points to new Navy destroyers, obviously stuffed with IT, costing \$3.2 billion apiece and laments “[w]e invest a lot in *this notion* of systems integration.”⁵⁰ (Italics added.) According to one estimate, \$17 billion was spent on integrated systems in 2005.⁵¹ One especially complex systems integration program, the Army’s Future Combat System, is coming under scrutiny for escalating costs now estimated at \$115 billion. Much of this system consists of computers and communications systems to share data among combat vehicles, prompting one to wonder whether DOD will enjoy the economic benefits of the astounding improvements in price-performance of computers and communications systems in the world at large.

⁵⁰ Speech by Terry Pudas, reported in *San Diego Union-Tribune*, October 18, 2005

⁵¹ Booz Allen Hamilton, quoted in *San Diego Union-Tribune*, October 18, 2005

What Can Be Done?

Suggestions and Cautions

We have several suggestions, all of which need more debate and analysis—what this article is intended to provoke. Begin by imagining an ideal defense industry from the standpoint of strong and affordable national defense:

- An end to principal agency (e.g., no lock on prime contracts for LSIs)
- Customers that understand how IT can be exploited to solve military operational problems and can manage acquisition programs without dependence on vendors
- Defense contractors that also participate in and are thus able to convey innovation and economies from wider markets
- Lower entry barriers and deterrence
- Unobstructed substitution of new solutions to defense problems using commercial IT

These conditions would give the defense industry higher ratings on Porter's five-forces framework and reduce concentration in the market, as measured in the Herfindahl-Hirschman Index. As important, the defense economy would be coupled with the larger, new information economy. Defense buyers would be stronger. National defense would benefit.

But be aware that achieving these conditions would require significant change from the status quo:

- Attracting top IT firms and other non-LSIs into the defense market would require major acquisition reform, at least for IT and IT-based systems.⁵² This would require revising the FAR and the platform-oriented contracting and program management that go with it.
- De facto protection of any LSI (or any other defense firm) would have to be ended. This will require letting the competitive chips fall where they may, discouraging teaming among LSIs that may serve them but not national defense, and being wary about acquisitions of smaller firms.
- System-of-systems management should be contracted for sparingly. This means that defense customers must be able to conceive and manage complex (including joint) IT-based solutions and procurements for and by themselves.
- Non-LSIs, such as major consulting firms with proven defense prowess, should be eligible to compete for large prime contracts.
- DOD should reduce purchases of services that reward and reinforce principal agency

The problem in effecting such reforms in defense tends to be more practical than intellectual. In this highly political-bureaucratic-regulatory environment, the status quo is more stubborn than it is if change is ordered by a board of directors or enacted by profit centers in a decentralized corporation. This makes it all the more important that acquisition reforms be rigorously analyzed, crafted, and targeted to produce real economic gain.

Before branding the above measures as naive, it is important to reflect on their importance. The market concentration of the LSIs is increasing. The dependence of defense customers on industry

⁵² See, for example, "Extending the User's Reach" by David Gompert, Charles Barry, and Alf Andreassen, *Defense & Technology Paper 24* (Washington, DC: Center for Technology and National Security Policy, March 2006), which calls for radical reform of acquisition of joint C4ISR.

for acquisition program management—a potential conflict of interest that destroys economic value—could grow as IT becomes more prevalent and joint capabilities become more common. Defense firms have never been less inclined to seek commercial business. Nor are they investing enough in human capital or innovation. A case for radical reform needs to be made to raise the level of discussion, which currently cycles between explanations like “defense is different” and appeals for realistic (i.e., marginal) change.

An Encouraging Closing Thought

There is little basis for believing that Defense, Inc., as it is, will undergo the sharp learning curve of productivity growth found in the private sector because the industry structure is so different. Efforts to reduce transaction costs from acquisition regulations and Congressional and service politics are unlikely to offer much change. The bureaucracy will not change itself, and the political process is unlikely to change the bureaucracy. Standing up yet another commission to explore ways for defense industry and the government to cooperate would, in our view, waste time—or do worse, if it called for closer partnership. The problem is not a lack of cooperation but too much of it. What is needed is competitive pressure.

One conclusion that stands out for us is the importance of the structure of the defense industry in determining behavior and results, no less than other industries. Let us make the case as starkly as possible. If the world's best CEOs (at GE, IBM, Toyota, Siemens) were plucked out of their companies and placed in charge of the LSIs, they would behave no differently than the LSIs do today. If anything, they might improve partnership with customers and acquisition of innovative firms, making the structure even less likely to generate real value and share economies.

Reforms and measures of the sort suggested above are indeed romantic, if the current industrial structure is preserved. However, it is not clear that the current structure will or can endure without either sharp degradation of its efficiency, greater support from the government, or both. There are a number of new small defense entrants and technology-based companies specializing in the intelligence market and new homeland-security market that could disturb the structure, weaken principal agency, improve productivity, and crack open the way for reform.

Moreover, major business challenges may await the LSIs. At the moment, their fortunes appear strong. In 2000 the LSIs had net profit margins averaging 4.3%; by 2005 these were 5.5%. Their price:earnings ratios—a measure of their appeal on Wall Street—went from 12:1 in 2000 to 18:1 in 2005. However, this is an industry that has always been cyclic, and cycles in defense investment (R&D and procurement) tend to be more extreme than cycles in aggregate defense spending. As funding for defense investment declines, owing to tight budgets and heavy current operating needs, the acquisition of big-ticket platforms will decline, which will hurt their financial performance. New products, like UAVs, PGMs and various networked capabilities should depress the buy rates of big-ticket defense platforms. Lacking the non-defense and global market “escape routes” that most corporations have, the major defense contractors cannot maintain the level of recent financial performance if defense spending plateaus, and if the American people and their representatives lose patience with high defense costs.

On both technological and political grounds, the potential exists for a change in defense industry structure in the years to come. The defense industry itself should change. Some of the big companies will exploit the opportunities and handle the challenges better than others, which must be allowed to suffer the consequences. This is the market-based nature of American capitalism. At the

same time, the worst thing the government could do is to permit the perpetuation of the current structure with even greater concentration.

Most LSIs lack significant commercial business to hedge against the cyclicalities of the defense market. The industry has undergone major changes many times in the past. By the 1970s the number of firms making fighters was reduced to a handful. In the 1990s, a vast consolidation occurred, albeit within the same basic structure. As pressures build on that structure in the future, the right solution for the nation is not further consolidation but the end of principal agency and the exposure of defense to the power of competition from the larger economy. The U.S. economy is more dynamic than any firm or structure within it. That dynamism should eventually be too strong for the current structure to endure in its present form, provided the government does not interfere.

With the defense-industrial structure due for change, we need to think about ways to lower the cost of defense and to increase the productivity of the defense economy by exploiting—better yet, joining—the new information economy. If and as the existing structure begins to buckle, the opportunity for restructuring will grow. Different scenarios of industry structural change suggest themselves, but exploring them would take us beyond the scope of this preliminary paper.

Of course, precisely because the LSIs have no hedge, they will vigorously defend their market positions. Their revenue streams and profit margins depend vitally on remaining principal agents, which can be self-perpetuating. Ending the debilitating reliance of military customers on the LSIs for management services will not be easy. If we are too sanguine about natural economic and technological pressures for changing the current industry, radical reform of the acquisition system will be all the more essential. In any case, it will take some combination of acquisition reform and industrial restructuring—with one reinforcing the other—to bring defense into the new IT economy and to harness the Nation's strategy to its economic and technological power.